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A P* APPROACH TO PRICE ADJUSTMENT IN DEVELOPING COUNTRIES: A PANEL STUDY

by

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A P* APPROACH TO PRICE ADJUSTMENT IN DEVELOPING COUNTRIES: A PANEL STUDY

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Abstract:

This paper examines the role of disequilibrium conditions in influencing price adjustment processes in developing countries.

Measures of real and financial sector disequilibrium are constructed for a sample of 58 developing countries over the period 1973-1998 using structural VAR methodology. Panel data techniques are used to estimate a reduced-form P* model.

Overall the results suggest that inflation expectations are relatively forward looking in developing countries. This is consistent with the elevated inflation rates that many of these countries have experienced over long periods of time.

The evidence for the role of real or financial sector disequilibrium conditions in the price adjustment process is limited. The output gap is significant for most countries, with the negative sign suggesting that temporary fluctuations in output, and subsequent price adjustment processes, reflect the response of output and prices to temporary supply shocks. The velocity gap does not seem to play an important role, and the external price gap appears only to be significant for the African and Western Hemisphere regions.

1. INTRODUCTION

There appears to be broad agreement in the literature that developing countries suffer from market imperfections and rigidities and that these factors often impede the role of prices in equilibrating markets. Under these conditions disequilibrium conditions and sluggish adjustment processes should have a prominent role in macroeconomic modeling.

In developed country literature, disequilibrium conditions generally enter the price adjustment equations through some measure of excess or deficient capacity in goods markets, such as the output gap or the unemployment rate. More recently, other disequilibrium measures have been revived, such as the money velocity gap (Hendry, 1995; Fung and Kasumovich, 1998) and the external price gap (Kool and Tatom, 1994; Garcia-Herrero and Pradha, 1998).

To date, however, disequilibrium conditions have generally not been incorporated into price adjustment models in developing country studies. Since developing countries are more likely to be faced with market imperfections and rigidities than developed countries – the conditions on which disequilibrium models are premised – it seems reasonable that this is the group of countries for which these models are likely to be most relevant and against which they should be tested.

This paper examines the role of disequilibrium conditions in influencing price adjustment processes in developing countries using a P* framework in the spirit of Hallman et al. (1989) and Corker and Hass (1991). Measures of real and financial sector disequilibrium are constructed for a sample of 58 developing countries using structural VAR methodology. Five regional subgroups are formed and panel data techniques are used to estimate a reduced-form P* model.

2. THEORY

A generalised P^* approach in the spirit Hallman et al. (1989) and Corker and Hass (1991) can be used to motivate a specification of a price adjustment equation that includes the real and financial sector disequilibrium. From a conventional long-run money demand equation there is an equilibrium price that is consistent with the current money stock such that:

$$p_t^* = v_t^* - y_t^* + m_t \tag{1}$$

where p* is the log of the equilibrium price level, v* is the log of the equilibrium (or trend) velocity, y* is potential output and m is the money stock. Actual prices, p, are given by:

$$p_t = v_t - y_t + m_t \tag{2}$$

where v is the current level of money velocity and y is the current level of income.

Subtracting (2) from (1):

$$\left(p_t^* - p_t\right) = \left(v_t^* - v_t\right) + \left(y_t - y_t^*\right) \tag{3}$$

The output or income gap in (3) is an indirect conduit for price pressures coming from the real sector of the economy. The money velocity gap – a measure of the extent to which current money holdings differ from that generally needed to support the current level of nominal output – may exert price pressures independently of those coming from the real sector.

Similarly from a long-run purchasing power parity condition there is an equilibrium price consistent with the current exchange rate such that:

$$p_t^* = p_t^{f*} + e_t^* \tag{4}$$

where p^{f*} is the log of the foreign price level and e^* is the log of the equilibrium exchange rate. If purchasing power is assumed to hold only in the long run, (4) can be written as:

$$p_t^* = p_t^{f*} + e_t - er_t^* \tag{5}$$

where er^* is the equilibrium real exchange rate. Accordingly:

$$p_t^* - p_t = (er_t - er_t^*) \tag{6}$$

The latter disequilibrium term is an external price gap and follows Kool and Tatom (1994) and Garcia-Herrero and Pradhan (1998). The foreign price gap measures the extent to which the domestic price level differs from the foreign-determined equilibrium price level. Many developing countries are relatively small countries that maintain a fixed exchange rate with larger, anchor countries. Under these conditions, monetary policy is largely given and the equilibrium price is the domestic currency price of the price in the anchor country. If prices are sticky, however, shocks to domestic or foreign prices may see periods of disequilibrium and protracted periods of adjustment. Edwards and Losada (1994) and Savvides (1998) find empirical support for this proposition.[1]

Combining (3) and (6) gives a general specification for the price gap:

$$(p_t^* - p_t) = (v_t^* - v_t) + (y_t - y_t^*) + (er_t - er_t^*) \tag{7}$$

Inflation dynamics are assumed to follow the process:

$$\Delta p_t = \delta \Delta p_{t-1} + (1-\delta)\Delta p_t^e + \alpha_i (p^* - p)_{t-1} + \upsilon_t \tag{8}$$

[1] Also see Savvides (1998) for additional references that provide supporting evidence.

A similar dynamic specification is used within the P^* framework by Svensson (1999).[2] Hallman et al. (1991) and Todter and Reimers (1994) use variants of (8). Expected inflation is used in (8) rather than lagged inflation or, steady state inflation as is used in some P^* models.

Substituting (7) into (8) and allowing the coefficients on the gap terms to be unconstrained, the price adjustment equation becomes:

$$\begin{aligned}\Delta p_t &= \delta \Delta p_{t-1} + (1-\delta)\Delta p_t^e + \alpha_5 \left(y - y^*\right)_{t-1} \\ &+ \alpha_4 \left(v^* - v\right)_{t-1} + \alpha_6 \left(er - er^*\right)_{t-1} + \upsilon_t\end{aligned} \tag{9}$$

No restrictions are placed on the coefficients of the respective gap components.[3] This allows both money and real sector disequilibrium, and external disequilibrium, potentially to have independent influences on the pattern of price adjustment.

3. CONSTRUCTING DISEQUILIBRIUM MEASURES

Since the 'equilibrium' levels of the variables in (9), and hence the disequilibrium terms, are not observable various econometric techniques are commonly used to construct them. These techniques include univariate and multivariate filters and structural models. The various methods of constructing output gaps have been reviewed in several recent papers including De Masi (1997), Dupasquier, Guay and St-Amant (1997) and St-Amant and Van Norden (1997). The construction of money gaps is discussed in Hendry (1995), Engert and Hendry (1998), Kasumovich (1996), Fung and Kasumovich (1998).

An alternative technique to the mechanical filters and the more sophisticated structural models discussed above, is the structural VAR technique. This method uses minimum theoretical

[2] The price gap term in Svensson's model is dated time t-1.

[3] It is common in the P^* literature to constrain the coefficients on the output gap and money gaps to be equal. However, some studies (for example, Corker and Hass, 1991) allow the coefficients to take on different values. Note that the restrictions are inappropriate where the effects of deviations from potential output are due to the effects of temporary supply shocks.

restrictions to identify the major shocks to the system and to decompose movements in the variables of interest into permanent and transitory components. Those shocks can then be used to construct the disequilibrium measures outlined above. A particular variant of that approach – based on long-run restrictions proposed by Blanchard and Quah (1989) and Shapiro and Watson (1988) – is used in this paper. Although this procedure is generally used to distinguish demand and supply shocks, the methodology can be thought of as a more general filter with which to identify permanent and transitory movements in variables (Scacciavillani and Swagel, 1999).

A bivariate vector autoregression system using output and price data is used to estimate permanent and transitory output shocks. This specification follows Bayoumi (1992) and Bayoumi and Eichengreen (1994), who extend Blanchard and Quah by using output and prices rather than output and unemployment. Bergman (1996) and Keating and Nye (1998) also use a bivariate VAR using output and price data. An analogous approach is used to recover the permanent and temporary shocks to money velocity and the real exchange rate. The structural shocks to money velocity are recovered from the bivariate system using money velocity and money data. The structural shocks to the real exchange rate are recovered from the bivariate system using real exchange rate and nominal exchange rate data, as in Lee and Enders (1993), Clarida and Gali (1995) and MacDonald and Swagel (1998).[4]

The identification procedure follows Blanchard and Quah (1989), using the simplification proposed by Lastrapes (1992). The procedure is detailed in Appendix 1.

The structural shocks estimated above are used to construct the disequilibrium terms. Following St-Amant and van Norden (1997) potential output is constructed as the level to which output reverts as the effects of demand disturbances, or temporary supply disturbances dissipate. It is assumed that shifts in potential output reflect permanent labour supply and productivity shocks – that is, those types of disturbances that are likely to have permanent effects on aggregate output.

[4] The approach of using three separate bivariate systems, rather than a single, larger system, reflects a number of considerations. In particular, long-run identification restrictions are unlikely to be able to distinguish between different nominal shocks. Identification restrictions based on arbitrary ordering restrictions or the absence of contemporaneous relationship among some of the variables are also likely to be inappropriate, particularly given the use of annual data in the study. The estimation of the separate models, rather than the larger system, has the added advantage of conserving degrees of freedom (Hoffmaister and Roldos, 1997), an important consideration given the limited data available for developing countries. Bivariate systems are widely used in the structural VAR literature.

Other disturbances, are treated as demand disturbances or temporary aggregate supply disturbances, that is the cyclical (or in the case of supply disturbances, irregular) component of output. Potential output is calculated as the sum of the projected deterministic trend in output and the cumulative effects of past permanent supply shocks:

$$y^*_t = \mu + A_1(L)\varepsilon_t^{r} \tag{10}$$

where y* is potential output, μ is the projected deterministic trend in output and ε^{as} are permanent aggregate supply shocks retrieved using the SVAR methodology. The output gap is given by:

$$\left(y - y^*\right)_t = y_t - \left(\mu + A_1(L)\varepsilon_t^{r}\right) \tag{11}$$

where y is actual output.

The monetary disequilibrium term is constructed in an analogous manner. In this case it is assumed that shifts in equilibrium velocity reflect longer-run structural and institutional shocks that have permanent effects on the relationship between income and money.[5] The cumulative effect on money velocity of temporary shocks, identified as shocks to money, is zero. Equilibrium money velocity is given by the sum of the projected deterministic trend in money velocity and the cumulative effects of past permanent velocity shocks. These shocks include policy shocks and shocks related to institutional and structural factors, which are common in developing countries (Corker and Hass, 1991):

$$v^*_t = \mu + C_1(L)\varepsilon_t^{v} \qquad 12)$$

where v* is the 'equilibrium' level of money velocity, μ is the projected deterministic trend in

[5] Bordo and Jonung (1987) find evidence of velocity cycles related to institutional factors.

money velocity and ε^{v} are permanent velocity shocks. Accordingly the velocity gap in equation (9) is given by:

$$(v_t^* - v_t) = (\mu + C_1(L)\varepsilon_t^v) - v_t \tag{13}$$

where v is actual money velocity.

The external price gap is constructed in an analogous manner to the other disequilibrium terms. In this case it is assumed that shifts in equilibrium real effective exchange rate reflect longer-run shocks – such as productivity shocks or permanent terms of trade movements – that have permanent effects on the relationship between domestic and foreign prices.[6] The cumulative effect on the real exchange rate of temporary shocks, identified as shocks to the nominal exchange rate, is zero. The equilibrium real exchange rate is given by the sum of the projected deterministic trend in the real exchange rate and the cumulative effects of past permanent real exchange rate shocks:

$$er_t^* = \mu + C_1(L)\varepsilon_t^v \tag{14}$$

where er^* is the 'equilibrium' level of the real exchange rate, μ is the projected deterministic trend in the real exchange rate and ε^{er} are permanent real exchange rate shocks. Accordingly the external price gap in equation (9) is given by:

$$(er_t - er_t^*) = (\mu + C_1(L)\varepsilon_t^v) - er_t \tag{15}$$

where *er* is actual real exchange rate.

[6] Note that it is possible for external prices to have an independent influence through the other disequilibrium terms.

4. ESTIMATION

The issue of heterogeneity is an important consideration when dealing with developing countries, since there are clearly significant institutional, structural and policy differences among them. The approach adopted here is to use a 'bare bones' theoretical structure that is consistent with a variety of well-accepted macro models but which imposes minimum restrictions on the short-term dynamics of economic processes. These basic models (bivariate SVAR systems) are estimated individually for each of the 58 countries in the study. In the second step, the countries are combined into five regional subgroups that appear to have broadly similar characteristics so as to draw some broader inferences about the dynamics of price adjustment.

The model was estimated using a sample of 58 developing countries using annual data over the period 1973 to 1998, with the starting point coinciding with the start of the post Bretton-Woods era.

Data are from the International Monetary Fund, International Financial Statistics, Yearbook, January 2000.[7] The price measure is the gross domestic product deflator (99b/99bp). The output measure is gross domestic product at constant prices (99b*p*). The income velocity measure of money is the ratio of nominal gross domestic product (99b) to money plus quasi-money (35l).[8]

The nominal exchange rate is the market rate (period average, national currency per unit of US$) (rf). The real exchange rate is the ratio of the domestic currency price of world tradeables to domestic prices, where world prices are calculated as an average of world import unit values and world export unit values (75d and 74d).[9]

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[7] The gross domestic product deflator is used, since this measure is generally regarded as the most comprehensive measure of a country's price level (Brajer, 1992).

[8] The broader measure of money is used to allow for shifts between different asset classes that have occurred during financial development and liberalisation in many of the developing countries covered in the study. Several other developing country studies have taken a similar approach (Laidler, 1999).

[9] While weighted-average trading partner inflation rates would be a preferred measure these data are generally not available for developing countries. However, the results are unlikely to be sensitive to the proxy used. Savvides (1998), for example, in a study of inflation in several developing African countries, finds that results are not sensitive to the choice of foreign price measures.

Expected inflation for t+1 was constructed by taking the one step ahead forecast from equation (9) to provide a model-consistent estimate of inflation rationally expected in period t+1, conditional on information available at time t and on the assumed specification of the inflation model.

The output gap, velocity gap and external price gap measures are constructed using the structural vector autoregression procedure described above.[10]

As a first step the statistical properties of the data were examined. The statistical properties of the data play an important role in the type of empirical analysis conducted in the paper. There are important differences, for example, in data that have a unit root process and those that have a trend stationary process. Shocks to difference stationary processes permanently shift the trend; shocks to trend stationary processes have a transitory effect as the effects dissipate over time.[11] Accordingly, identification of permanent and transitory shocks to series requires different techniques depending on the nature of the data generating process. Similarly, the types of transformations that are necessary to induce stationarity will vary depending on the statistical properties of the data.

The structural VAR approach requires that the growth rate of output (or other series that is to be decomposed) follows a stationary stochastic process. The order of integration of the other variables in the VAR can vary. An I(1) or I(2) variable can be differenced accordingly and a trend-stationary variable can be used by taking the residuals from the deterministic trend.

Three tests were used to examine the order of integration of the series: the Augmented Dickey-Fuller[12] (ADF) test, the Phillips-Perron (1988) (PP) test and the Kwiatowski, Phillips, Schmidt &

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[10] Where the statistical properties of the data were incompatible with the SVAR technique, gaps were constructed using the Hodrick-Prescot filter.

[11] The statistical properties of major macroeconomic time series remain conjectural. Nelson and Plosser (1982) demonstrated that macroeconomic variables are difference stationary rather than trend stationary. Perron (1989) used the same data and concluded that the variables are trend stationary. In a comprehensive study, including over 100 developing countries, Cheung and Chinn (1996) found evidence that, where an unambiguous result could be obtained, output was difference stationary rather than trend stationary.

[12] See Dickey and Fuller (1979), Dickey and Pantula (1987) and Said and Dickey (1984).

Shin (1992) (KPSS) test. The ADF test tests the significance of the lagged level of a variable in an autoregressive equation in which sufficient dynamics have been added to eliminate autocorrelation. The null hypothesis is a unit root. The PP test is similar to the ADF test but a non-parametric adjustment is used to correct for the ARMA process. The KPSS test is designed to be used in conjunction with the other tests, and has a null hypothesis of either trend stationarity or levels stationarity.

The results (not reported here) suggest that output is generally I(1) although for several countries the evidence suggests that it is trend stationary.[13] Similarly for money velocity and the real exchange rate the results suggest that for most countries the series are I(1), but for some countries it is likely to be trend stationary, or levels stationary. Prices, money and nominal exchange rates generally appear to be I(1), but for several countries the results suggest that the series may be better described by I(2) processes. Accordingly, the series need to be differenced once or twice as necessary to satisfy the stationary requirements of the structural VAR technique.[14] For a couple of countries, prices appear to be trend stationary, in which case residuals from the detrended series were used in the structural VAR.

The possibility of cointegration between the variables was tested using the Johansen and Juselius (1990) estimation procedure.[15] As applied here the maximium likelihood estimator is a bivariate version of the Dickey-Fuller test. The unrestricted model included a constant. The test statistic, λ_{trace} tests the null hypothesis that the number of cointegrating vectors are less than or equal to r. The lag value was chosen to provide the most parsimonious model while ensuring that no residual autocorrelation was present. The possibility of residual autocorrelation was tested using the Ljung-Box test (Ljung and Box, 1978) and LM tests for first and fourth-order autocorrelation (Godfrey, 1988). Critical values for the cointegration tests are from Johansen and Juselius (1990).

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[13] The results of the various statistical tests for each of the 58 countries are not reported here because of space constraints. Test results are available on request.

[14] Although the order of integration of prices remains a controversial area, Phillips (1995) shows that the SVAR technique performs badly if either non-stationary or quasi-non-stationary series are used.[14] Accordingly, the change in inflation is included in the vector autoregession for those countries where the unit roots tests could not reject the hypothesis that prices are I(2).

[15] The tests were performed using the CATs for RATs program (Hansen and Juselius 1995).

Unfortunately, the asymptotic distributions of the test statistics estimated using the Johansen and Juselius procedure are unlikely to be a good approximation of the underlying small sample distribution (Hansen and Juselius, 1995), so the test statistics provide only a rough guide as to the possibility of cointegrating relationships among the variables. To complement these statistics the eigenvalues of the companion matrix were examined.[16] The number of common stochastic trends in the data correspond to the number of roots close to unity (Hansen and Juselius, 1995). The eigenvalues are well below unity, indicating that there is little evidence to support the existence of cointegrating relationships in the model. From this evidence, and theoretical priors, we proceeded on the assumption of no cointegrating vectors in the respective series. Since, however, some of the λ_{trace} statistics were significant (based on the asymptotic distributions) some caveats may apply.[17]

The three disequilibrium terms were estimated for each individual country using the structural VAR procedure outlined in Appendix 1. Estimation was conducted using RATS software.

The first step in the process was to estimate reduced-form VARs for each country in the sample. The bivariate systems are described in Appendix 1. The real variables – output, money velocity and the real exchange rate – were first differenced; the nominal variables – prices, money and the nominal exchange rate – were differenced once or twice, depending on the order of integration, or taken as a deviation from trend in the case of trend stationary series.[18]

The lag structure of the VARs was determined using likelihood ratio tests based on a general to specific approach. Generally the tests indicated a lag length of one, although in a few cases two lags were necessary to ensure the null of no autocorrelation was rejected. However, DeSerres and Guay (1995) caution against using the standard information criteria, since they often result in the inclusion of an insufficient number of lags. A one-period lag length may be inadequate to

[16] The eigenvalues are the reciprocal of the roots of the characteristic equation.
[17] The cost of assuming no cointegration would be in the over-differencing of the variables in the VAR.
[18] Where the real variables were I(2) or trend stationary, the SVAR procedure was not appropriate. In these cases, a HP decomposition was used to estimate the gap terms.

properly capture the dynamic responses of the system to economic disturbances (Ahmed and Park, 1994). Accordingly, a lag length of two was used for all countries.[19]

The structural shocks were recovered as described in Appendix 1 and the gap terms constructed as per equations (11), (13) and (15). Summary statistics for the full sample and for each of the regional subgroups are shown in Table 1.

***Table 1*: Summary Statistics**

	Africa	Asia	Middle East	Western Hemi.	Western Hemi. (high)	All
Inflation						
Average	0.17	0.09	0.11	0.14	0.61	0.20
Standard deviation	0.18	0.07	0.23	0.10	0.81	0.37
Output Gap						
Average	0.00	0.00	0.00	0.00	0.00	0.00
Standard deviation	0.04	0.03	0.06	0.03	0.04	0.04
Velocity Gap						
Average	0.00	0.00	0.00	0.00	0.00	0.00
Standard deviation	0.06	0.03	0.06	0.04	0.13	0.07
External Price Gap						
Average	0.00	0.00	0.00	0.00	0.00	0.00
Standard deviation	0.15	0.06	0.21	0.13	0.10	0.13

The model (equation 9) was estimated using pooled cross-country time series estimation. The basic form of the regression model is given by:

$$y_{it} = X_{it}\beta + u_{it} \qquad (16)$$

where i = individuals i...N and u_{it} is an error term that varies across countries and over time.

[19] As part of the early screening the residuals from the reduced form VAR were examined for the presence of outliers. While outliers can contain useful information at times, they may also reflect measurement problems, breaks in series and one-off shocks that cannot be adequately covered in a parsimonious model specification. These distortions are likely to be particularly important for developing countries. Outliers were omitted from the reduced form VAR if they exceeded three standard errors.

Estimation is complicated by the possibility that the error term u_{it} may be systematically higher for some countries than for others.[20] If this is the case, Ordinary Least Squares estimation will be inappropriate. Typically, two alternative techniques are used to deal with this problem (see Hausman and Taylor, 1981). The first technique – the fixed effects estimator – involves using a separate intercept for each country. The second technique – the random effects estimator – decomposes u_{it} into individual effects, time effects and random effects and estimates the coefficient vector using Generalised Least Squares. The preferred technique depends on the structure of the error term and the correlation between the components of the error term and the regressors. The latter technique may give biased results if the unobservable effects, which have been included in the error term, are correlated with one of the regressors. On the other hand the fixed effects estimator may be less precise because of the large number of additional number of parameters to be estimated.

For the fixed effects estimator the series was first transformed by subtracting individual means from each series. The model was then estimated by OLS with a correction made for the loss of degrees of freedom caused by the removal of individual means. Preliminary tests (reported in Table 1) pointed to the presence of heteroscedasticity and autocorrelation in the residuals.[21] Accordingly, consistent estimators for the covariance matrix in the presence of heteroscedasticity and autocorrelation of unknown forms were computed as in Hansen (1982) and White (1980). Outliers were removed using a cuttoff criteria of three standard errors on the residuals from a preliminary regression.

For the random effects estimator a preliminary OLS regression was run to obtain the residuals. The residuals were decomposed into individual and random effects and the series were transformed by subtracting the product of theta and the individual means from each series.[22] The model was then estimated by OLS. The heteroscedasticity and autocorrelation consistent estimators for the covariance matrix were computed as in the fixed effects case.

[20] There is also a possibility that u_{it} may be systematically higher in some time periods than in others.

[21] One possible source of autocorrelation was omitted variables. Another possible source is measurement error of the dependent variable, a potentially important source of error in developing country data. Johnston (1984), for example, notes that formalised routines and procedures that are used to produce estimates can induce non-random patterns into the residuals.

[22] Theta is calculated as $1-\sqrt{\sigma_{nit}/(\sigma_{nit}+n\sigma_{ei})}$ where σ_{nit} is the variance of the random effect and σ_{ei} is the variance of the individual effect.

Hausman tests were conducted to distinguish between the fixed and effects estimators. The results pointed to significant differences between the estimators, suggesting that the random effects estimator is likely to be biased because of correlation between the individual effects and the regressors. Accordingly only the fixed effects results are reported below.

Chow tests using subsample regressions were used to assess whether there were significant differences between the full sample and each of the regional subsamples. The results suggested that there were significant differences between the groups, as expected given the likelihood of substantial institutional, structural and policy differences between developing countries. Accordingly the five regional subgroups – Africa, Asia, Middle East, Western Hemisphere and Western hemisphere (high inflation) – were estimated separately. The results are shown in Tables 2 and 3.

5. RESULTS

The results provide mixed support for the role of disequilibrium conditions in goods and financial markets in the process of price adjustment. The output gap is significant for most countries, with the negative sign suggesting that temporary fluctuations in output, and subsequent price adjustment processes, reflect the response of output and prices to temporary supply shocks. The external price gap appears only to be significant for the African and Western Hemisphere regions. The velocity gap does not seem to play an important role.

For Africa, the evidence points to forward-looking inflation expectations, consistent with Africa history of sharply elevated inflation rates in many countries. Of the disequilibrium terms, both the velocity gap and the external price gap are significant at the 1 and 5 percent levels respectively. The coefficient on the external price gap has the expected positive sign with higher foreign prices relative to domestic prices eventually being eliminated through domestic price increases.

For Asia, expectations appear to be largely forward looking. Only the output gap term is significant. The sign on the output gap term is negative, suggesting short-term fluctuations in output is dominated by the effects of temporary supply shocks. For the Middle East none of the three gap terms are significant at the 5 percent level.

For both Western Hemisphere subgroups, the results suggest that expectations are very forward looking. For the Western Hemisphere subgroup each of the gap terms are significant; for the

***Table 2*: Regional Subgroups: Africa, Asia, Middle East**

Dependent variable: Inflation *Sample period:* 1976-1998 *Estimation method:* Fixed effects *Explanatory variables:*	Africa	Asia	Middle East
Exp. Inflation	0.8674** (0.0285)	0.7047** (0.0342)	0.8080** (0.0391)
Lagged Inflation	0.1326** (0.0285)	0.2953** (0.0342)	0.1920** (0.0391)
Output gap	-0.0200 (0.0888)	-0.2883** (0.0474)	0.0537 (0.0874)
Velocity gap	-0.1453* (0.0573)	0.1034 (0.0625)	-0.0120 (0.1291)
External Price Gap	0.1321** (0.0172)	0.0295 (0.0426)	-0.0155 (0.0261)
General Statistics:			
$R(bar)^2$	0.77	0.57	0.77
Degrees of Freedom	344	228	150
Standard Error of Estimate	0.0698	0.0358	0.0868

Notes: standard errors in parentheses; *(**) denote significance at the five(one) percent level. Final regression uses consistent estimate of the covariance matrix allowing for heteroscedasticity and serial correlation as in White.

Western Hemisphere High Inflation subgroup only the output gap term is significant. As with the other subgroups it has a negative sign, pointing to the importance of lagged adjustment to supply shocks in the price adjustment process.

The relatively unimportant role of the monetary disequilibrium term is somewhat at odds with other studies that show an important role foe monetary shocks in the price adjustment process. However, it should be remembered that the gaps are constructed using shocks to velocity – that is the unexpected component of a monetary impulse. Anticipated changes in money, and accommodating policy responses to other disturbances are likely to show up in the expected inflation terms. The other possibility is that the annual periodicity masks some of the higher frequency responses of prices to money processes.

***Table 3*: Regional Subgroups: Western Hemisphere 1 and 2**

Dependent variable: Inflation *Sample period:* 1976-1998 *Estimation method:* Fixed Effects *Explanatory variables:*	Western Hemisphere	Western Hemisphere (High Inflation)
Exp. Inflation	0.9684** (0.0191)	0.7837** (0.0142)
Lagged Inflation	0.0316 (0.0191)	0.2162** (0.0142)
Output gap	-0.1767** (0.0381)	-0.9822** (0.3656)
Velocity gap	0.2374** (0.0495)	0.3301 (0.1770)
External Price Gap	0.0712** (0.0103)	0.1109 (0.1755)
General Statistics: $R(bar)^2$ Degrees of Freedom Standard Error of Estimate	 0.68 245 0.0861	 0.85 148 0.2574

Notes: standard errors in parentheses; *(**) denote significance at the five(one) percent level. Final regression uses consistent estimate of the covariance matrix allowing for heteroscedasticity and serial correlation as in White.

6. CONCLUSION

Overall the results suggest that inflation expectations are relatively forward looking in developing countries. This is consistent with the elevated inflation rates that many of these countries have experienced over long periods of time.

The evidence for the role of disequilibrium conditions in the price adjustment process is limited. The output gap was significant for three of the five regional groups, with the negative sign suggesting that temporary fluctuations in output, and subsequent price adjustment processes, reflect the response of output and prices to temporary supply shocks. The external price gap appears only to be significant for the African and Western Hemisphere regions. The velocity gap does not seem to play an important role, at least within the specification proposed here.

The policy implications of the results are somewhat limited. The important role of inflationary expectations in inflation processes suggests that institutional reforms that provide a credible nominal anchor may help produce better inflation outcomes; structural reforms that increase price flexibility may also help reduce inflation inertia. The absence of clear evidence of excess demand and supply influences operating through the goods and factor markets provides little support for traditional short-term demand management policies.

One issue that is not addressed here is whether or not the assumption of linearity in the model specification, unduly constrains the results. In the developed-country literature there is increasing recognition that market imperfections and rigidities may induce nonlinear and possible asymmetric responses of prices to disequilibrium conditions. More comprehensive research – currently underway – will extend the above research in this direction.

APPENDIX 1: CONSTRUCTION OF THE GAP TERMS USING STRUCTURAL VAR METHODOLOGY

The identification procedure follows Blanchard and Quah (1989), using the simplification proposed by Lastrapes (1992). The shocks identified by the SVAR procedure are used to construct the disequilibrium terms using the procedure described in St-Amant and van Norden (1997) and Hoffmaister and Roldos (1997), and outlined below.

A bivariate vector autoregression system using output and price data is used to estimate permanent and transitory output shocks.[23] This specification follows Bayoumi (1992) and Bayoumi and Eichengreen (1994), who extend Blanchard and Quah by using output and prices rather than output and unemployment. Bergman (1996) and Keating and Nye (1998) also use a bivariate VAR using output and price data.[24]

The model is expressed as an infinite moving average representation of the variables such that:

$$\Delta x_t = A_0 \varepsilon_t + A_1 \varepsilon_{t-1} + \ldots = \sum_{i=0}^{\infty} A_i \varepsilon_{t-i} = A(L)\varepsilon_t \qquad \text{(A1)}$$

where $\Delta x_t = \begin{bmatrix} \Delta y_t \\ \Delta p_t \end{bmatrix} \qquad \Delta \varepsilon_t = \begin{bmatrix} \varepsilon_t^P \\ \varepsilon_t^T \end{bmatrix}$

It is assumed that the change in output, Δy, and the change in prices, Δp, are stationary, and that the permanent and transitory structural errors, ε^P, and ε^T respectively, are uncorrelated white

[23] The VAR is constructed so that there is no direct feedback from domestic to foreign variables. This follows the small country open economy assumption, which is common in the literature. Other VAR studies of developing countries that have explicitly included foreign variables have used this assumption as an identifying restriction (Ahmed and Park, 1994; Hoffmaister, and Roldos, 1996; Hoffmaister, and Roldos, 1997).

[24] The choice of a bivariate system reflects both theoretical and practical considerations. The approach is relatively straightforward and the underlying assumptions are consistent with a standard AS-AD framework. It has the advantage that it has limited data requirements. This is an important consideration – the paucity of developing country data, and their poor quality, is well-recognised (Heston, 1994; Srinvasan, 1994). While there may be some gains to be had by including more information to identify the structural components, there is increased difficulty in supporting the additional identifying restrictions and there is also a cost in terms of less precise estimates.

noise disturbances. The variance of the structural shocks is normalised so that E($\varepsilon_t \varepsilon_t$) = I, the identity matrix.

The moving-average representation of the reduced-form of the model is:

$$\Delta x_t = e_t + C_1 e_{t-1} + \ldots = \sum_{i=0}^{\infty} C_i e_{t-i} = C(L) e_t \tag{A2}$$

where e_t is a vector of estimated reduced-form residuals with variance E($e_t e_t$) = Ω and the matrices C_i represent the impulse response functions of shocks to Δy and Δp.

From (A1) and (A2) it follows that the structural innovations are a linear transformation of the reduced-form innovations. The reduced-form residuals are related to the structural residuals by:

$$e_t = A(0)\varepsilon_t \tag{A3}$$

where $A(0)$ is a matrix of the contemporaneous effects of the structural innovations. It follows that:

$$E\left(e_t e_t\right) = A(0) E\left(\varepsilon_t \varepsilon_t\right) A(0)' \tag{A4}$$

and since E($\varepsilon_t \varepsilon_t$) = I:

$$A(0)A(0)' = \Omega \tag{A5}$$

To recover the structural innovations it is necessary to provide sufficient restrictions to identify the elements of the matrix $A(0)$.

From equations (A1) and (A2) note that C(0) = 0 and hence:

$$A(0)\varepsilon = e \tag{A6}$$

Lagging (A6) gives:

$$A(j)\varepsilon_{-j} = C(j)e_{-j} \tag{A7}$$

and therefore:

$$A(j) = C(j)A(0) \tag{A8}$$

Using the simplification proposed by Lastrapes (1992), from (A8) for j=1:

$$A(1) = C(1)A(0) \tag{A9}$$

and using (A5):

$$A(1)A(1)' = C(1)\Omega C(1)' \tag{A10}$$

Where $A(1)$ is lower triangular (as in the case where the cumulative effect of an ε^T shock on the Δy sequence is equal to zero), it can be calculated as the lower Choleski decomposition of $C(1)\Omega$ $C(1)'$. The matrix $A(0)$ is then calculated as:

$$A(0) = C(1)^{-1}A(1) \tag{A11}$$

This allows the retrieval of the structural shocks using the residuals from (A2).

The exogenous shocks identified from the bivariate structural models (A1-A11) and the A matrix of coefficients can be used to construct measures of the output gap.

Following St-Amant and van Norden (1997) potential output is constructed as the level to which output reverts as the effects of demand disturbances, or temporary supply disturbances dissipate –

that is, the level of aggregate output achievable over time without placing undue pressures on resources. It is assumed that shifts in potential output reflect permanent labour supply and productivity shocks – that is, those types of disturbances that are likely to have permanent effects on aggregate output. Other disturbances, are treated as demand disturbances or temporary supply disturbances, that is the cyclical (or in the case of supply disturbances, irregular) component of output. From equation (A1) potential output, y^*, is given by the sum of the projected deterministic trend in output and the cumulative effects of past permanent supply shocks:

$$y^*_t = \mu + A_1(L)\varepsilon^P_t \tag{A12}$$

where μ is the projected deterministic trend in output and ε^P are permanent aggregate supply shocks. The output gap is given by:

$$(y - y^*) = y_t - (\mu + A_1(L)\varepsilon^P_t) \tag{A13}$$

An analogous approach is used to recover the permanent and temporary shocks to money velocity and the real exchange rate, and to construct the disequilibrium terms. Although the Blanchard and Quah (1989) procedure is generally used to distinguish demand and supply shocks, the methodology can be thought of as a more general filter with which to identify permanent and transitory movements in variables (Scacciavillani and Swagel, 1999). In our case, the procedure is used to distinguish between permanent and transitory movements in velocity (and below, in the real exchange rate). Two kinds of disturbances are assumed. The first type of disturbance is assumed to have no long-run effects on money velocity.[25] These shocks are interpreted as nominal disturbances. The shocks disrupt the relationship between money, prices and income, with the supply of money temporarily in excess or deficit of desired levels. The shock may be associated with, for example, a temporary money overhang or with interest rates being higher or lower than those usually associated with a given level of demand (Corker and Hass, 1991). Over time, however, prices (and money) adjust, output returns to the long-run equilibrium level and there are no permanent changes in money velocity. The second type of disturbances is those that

[25] Note that while it is possible that the cumulative effects of money (and the exchange rate in the third bivariate system) may not be zero, Blanchard and Quah (1989) show that the only requirement for the identification procedure is that the effect of the nominal shock in the long run be relatively small compared with the real shock.

have permanent effects on money velocity – that is, shocks that permanently change the relationship between money, prices and income. These shocks may include, for example, financial deepening, and financial innovation, financial market deregulation and liberalisation.[26]

The structural shocks to money velocity are recovered from the bivariate system where:

$$\Delta x_t = \begin{bmatrix} \Delta v_t \\ \Delta m_t \end{bmatrix} \quad \Delta \varepsilon_t = \begin{bmatrix} \varepsilon_t^P \\ \varepsilon_t^T \end{bmatrix} \tag{A14}$$

where Δv is change (log difference) in money velocity, Δm is change (log difference) in money, and ε^P, and ε^T are the permanent and transitory structural errors respectively.

The shocks are recovered as described in equations (A1) to (A11) and the velocity terms constructed as per equations (A12) and (A13).

Consistent with the estimation of the other gap measures used in this paper, structural vector autoregression methodology is also used as a general filter to provide an estimate of equilibrium real exchange rate and the external price gap. The use of this technique follows Lee and Enders (1993), Clarida and Gali (1995) and MacDonald and Swagel (1998).

The structural vector autoregression procedure is used to distinguish between permanent and transitory movements in the real exchange rate. Two kinds of disturbances are assumed. The first type of disturbance is assumed to have no long-run effects on the real exchange rate. These shocks are interpreted as nominal disturbances and may include for example, temporary increases in government spending. The shocks are assumed to temporarily disrupt the relationship between domestic prices and foreign prices. When prices are above the equilibrium (foreign-determined) price level, there is downward pressure on domestic prices and/or the exchange rate; when domestic prices are below the foreign equivalent there is upward pressure on the price level and/or the exchange rate. Over time, however, prices (and/or the exchange rate) adjust to restore

[26] See Bordo and Jonung (1990) and references therein for a discussion on the influence of institutional change on money velocity.

the real exchange rate to its long-run equilibrium level. The second type of disturbances are those that have permanent effects on the equilibrium real exchange rate. These shocks may include, for example, productivity shocks and permanent terms of trade shocks that permanently change the value of one country's commodity basket, relative to that of another country's basket.[27]

Following Enders (1995), the structural shocks to real exchange rate are recovered from the bivariate system where:

$$\Delta x_t = \begin{bmatrix} \Delta er_t \\ \Delta e_t \end{bmatrix} \quad \Delta \varepsilon_t = \begin{bmatrix} \varepsilon_t^P \\ \varepsilon_t^T \end{bmatrix} \tag{A15}$$

where Δer is change (log difference) in the real exchange rate, Δe is change (log difference) in the nominal exchange rate, and ε^P, and ε^T are the permanent and transitory structural errors respectively.

The shocks are recovered using the same procedure as described by (A1) – (A11) and the external gap terms constructed using an analogous procedure to that in equations (A12) and (A13).

[27] See Aghevli et al. (1991) for a comprehensive discussion of the factors influencing the evolution of real and nominal exchange rates in developing countries.

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